Consortium for Energy, Economics and the Environment

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Mercury Transport and Deposition in Ohio River Valley Region: Measurements at a Rural Super Site in Athens, Ohio

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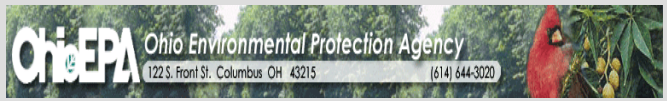
Atmospheric and Environmental Research

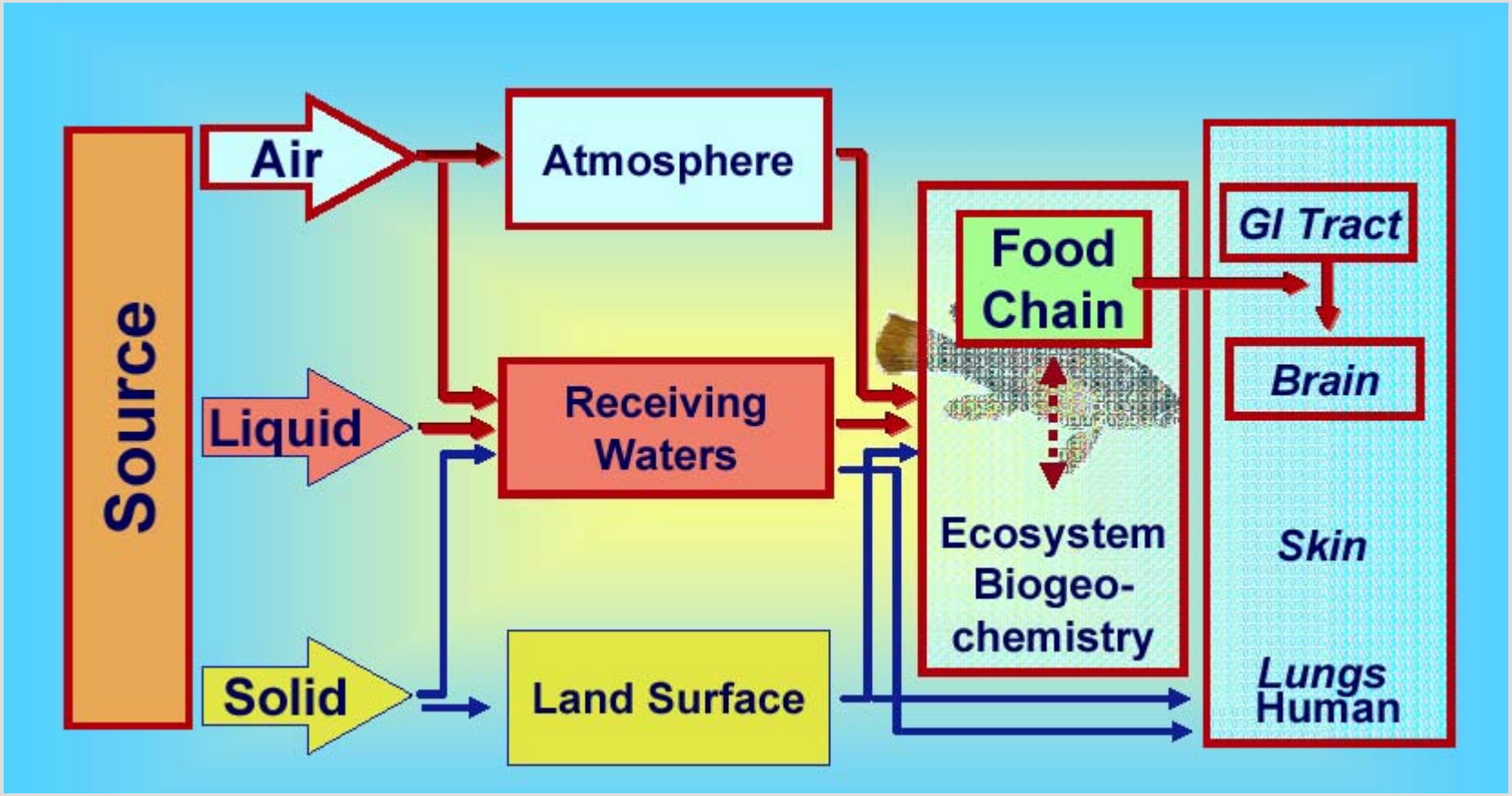
Consol Energy

Ohio EPA



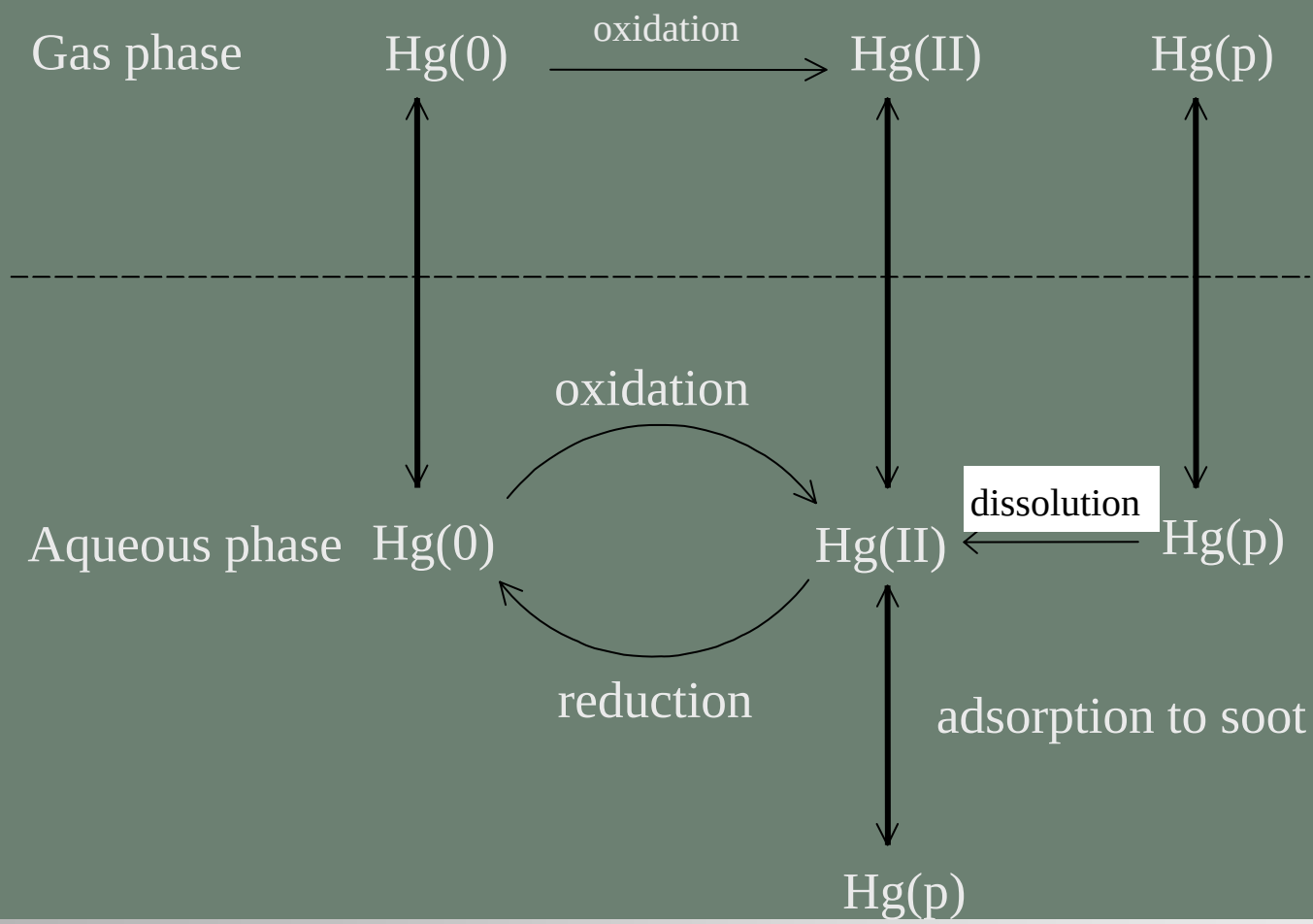
Ohio University

Potential Toxic Exposure in Humans
(major pathways are in red)

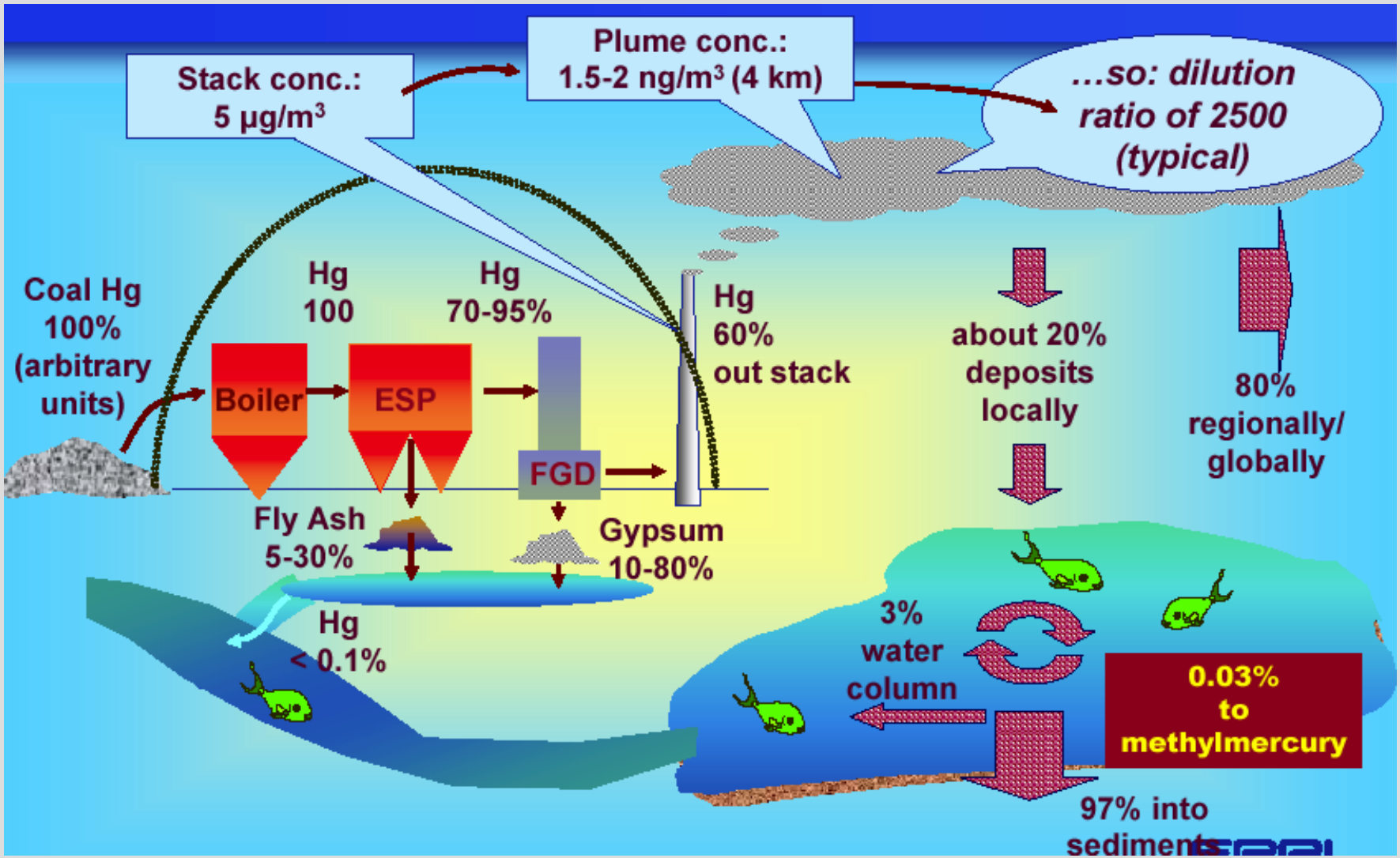


Source: Leonard Levin, Valuing Externalities Workshop,

Atmospheric Chemistry of Mercury



Fate of Mercury Emissions from Power Plant
-from METAALICUS and Aircraft Measurements



Source: Leonard Levin, Valuing Externalities Workshop,

Project Objectives

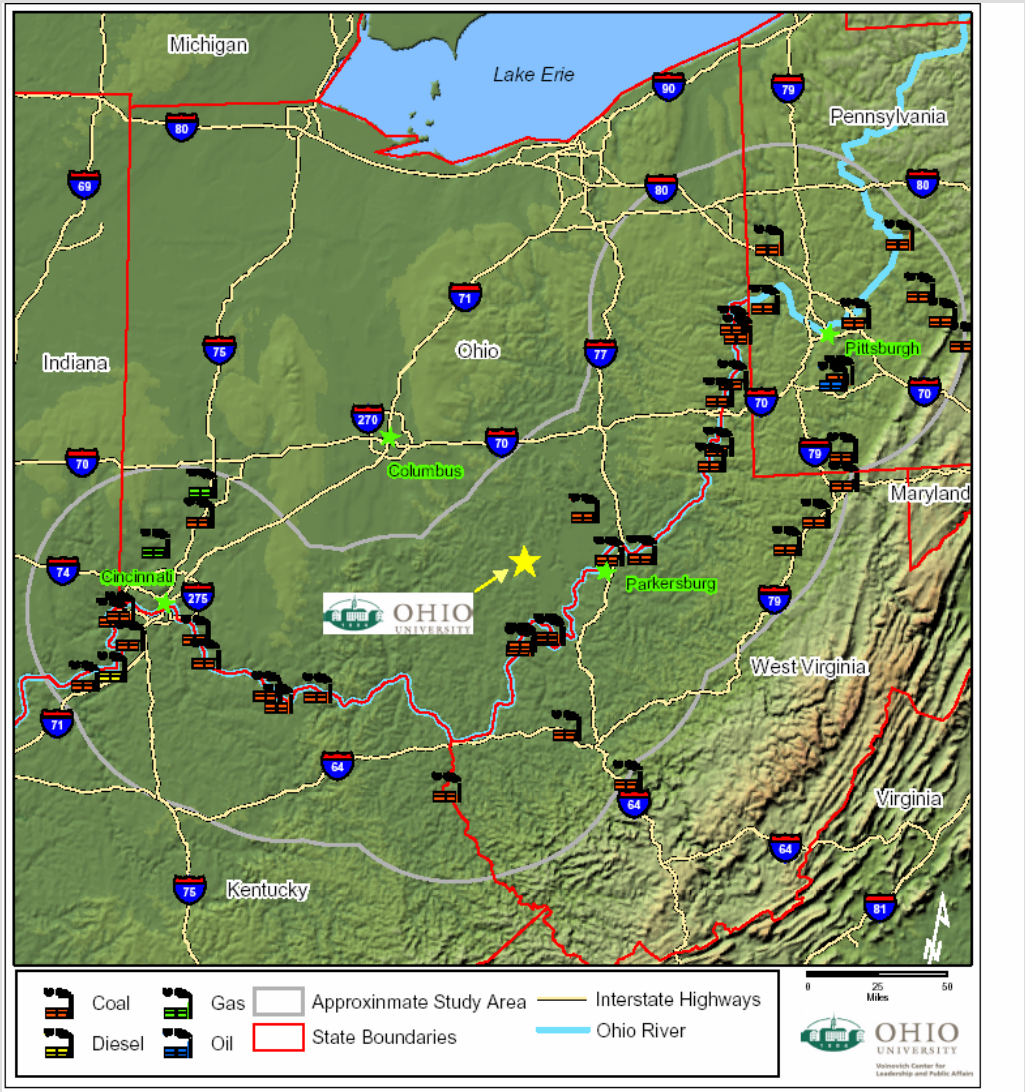
Quantitatively evaluate the emission, transport and deposition of mercury, arsenic and fine particulate matter in the Ohio River Valley region

- Ambient Monitoring
- Regional-Scale Modeling Analysis

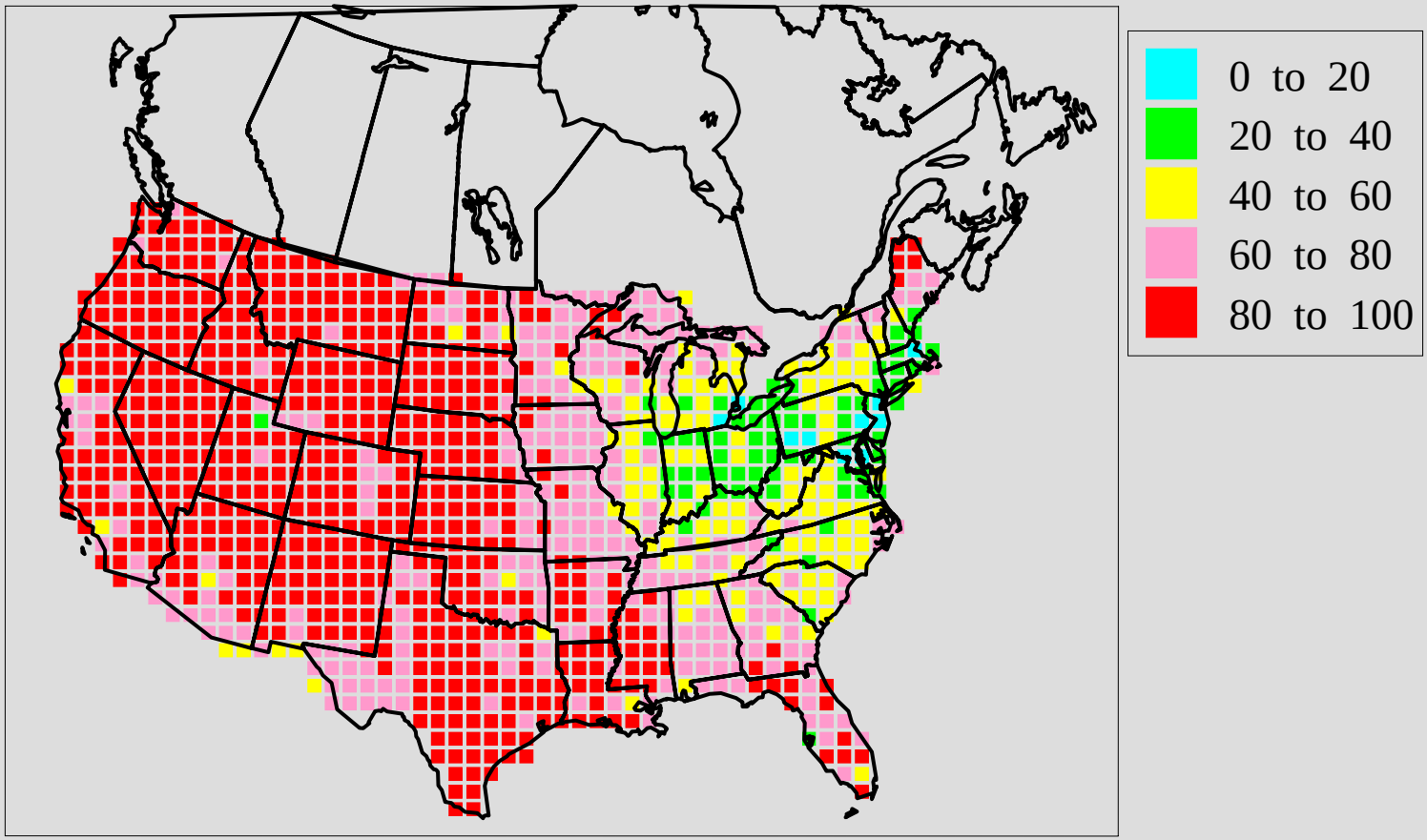
Anticipated Benefits

Provide critical information for the development of relevant and cost effective control strategies

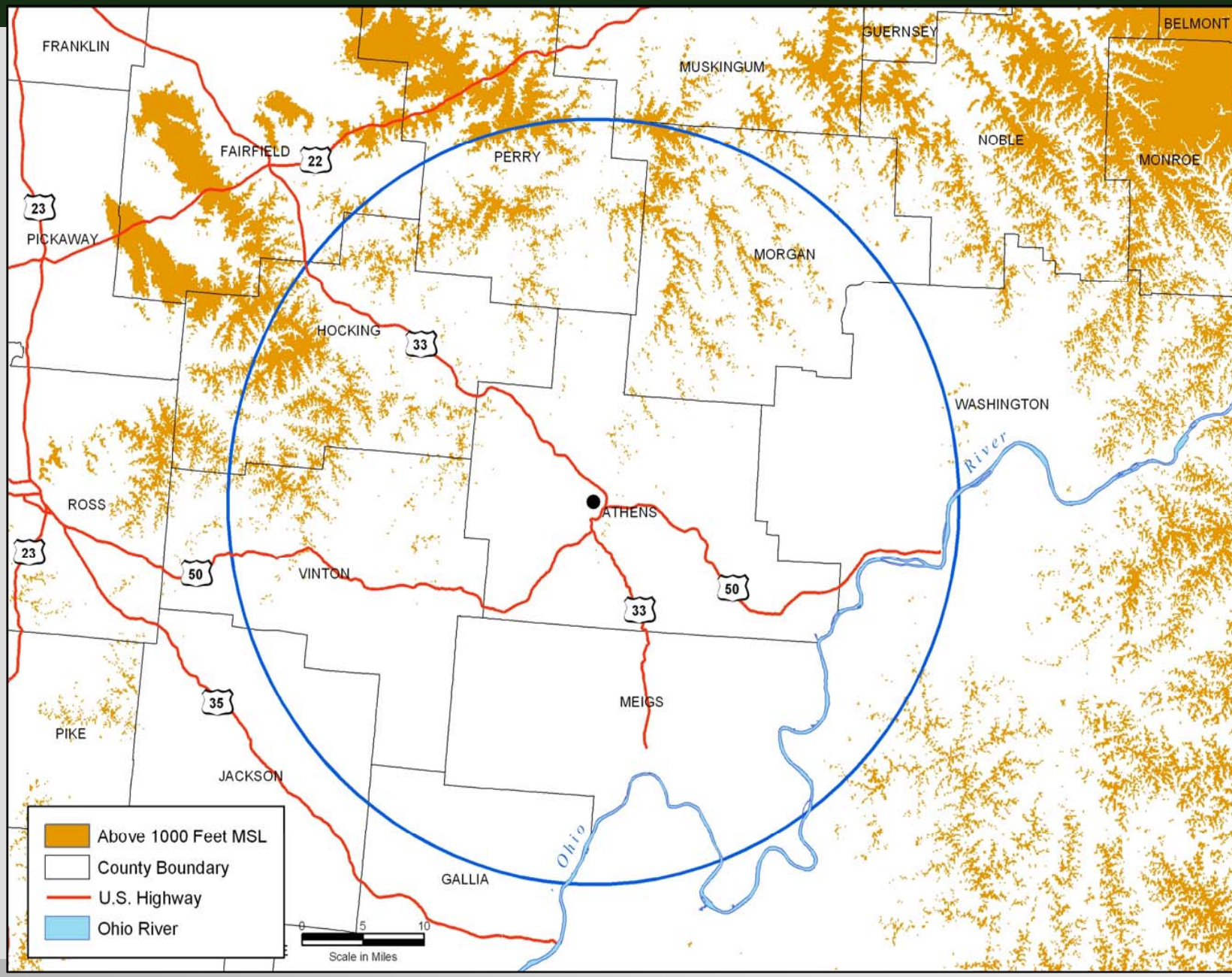
Ohio River Valley



Contribution of the Global Background to Mercury Deposition (%)

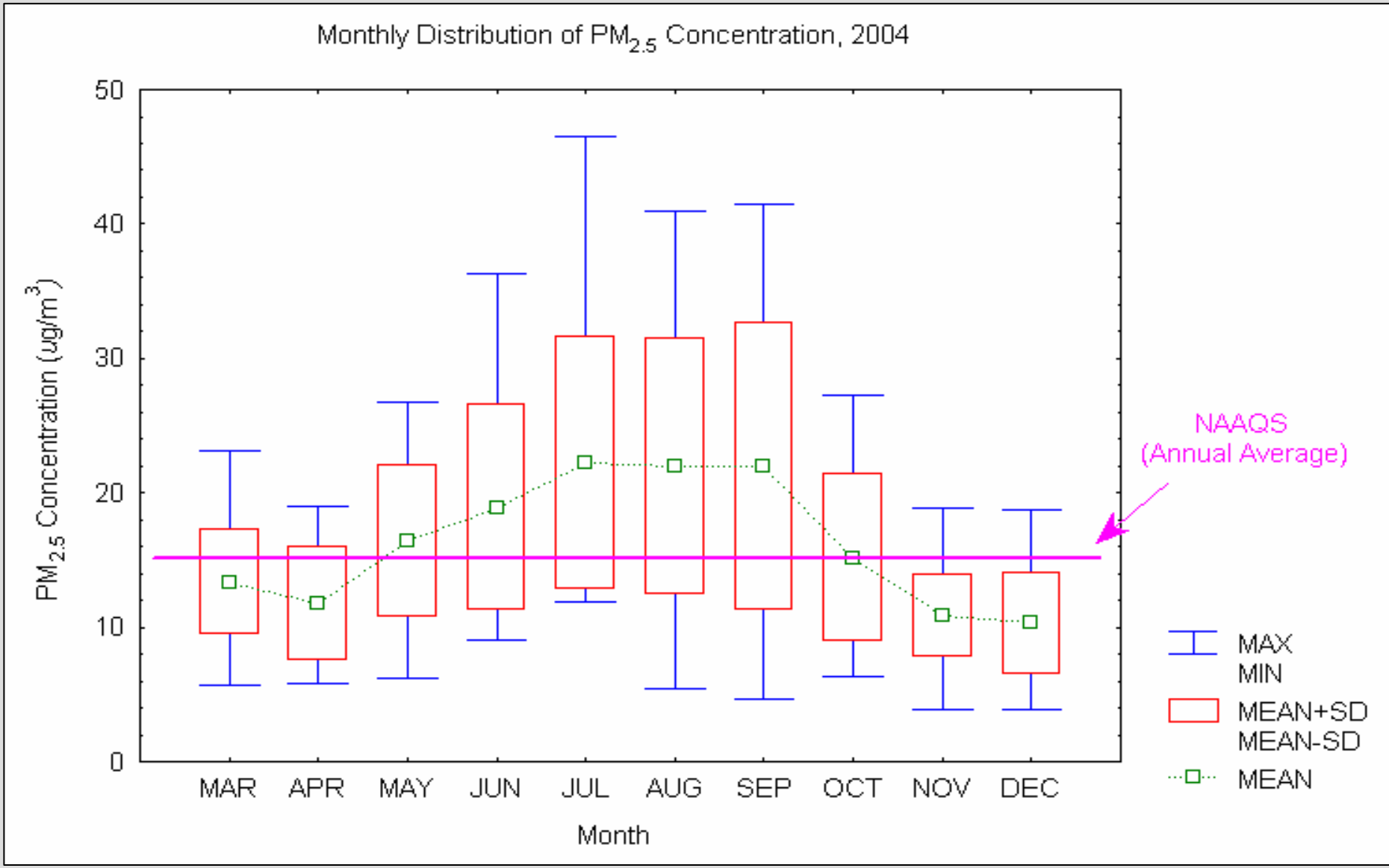



Elevation: approx 1000 ft asl
Latitude: 39.3º N
Longitude: 82.11º W
1375 ft asl

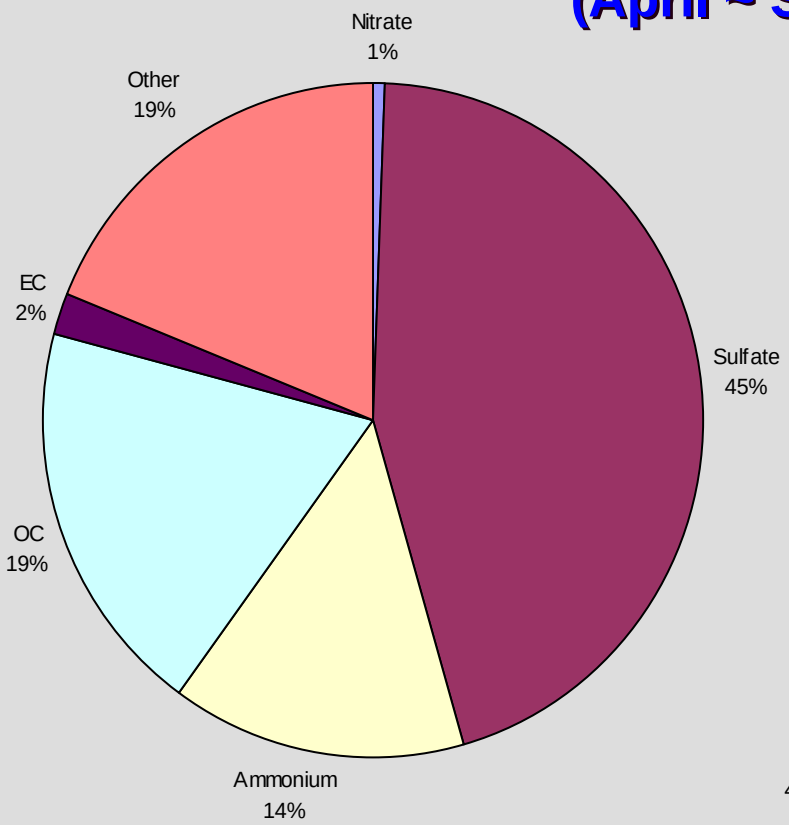

FRANKLIN
FAIRFIELD
22
PERRY
MUSKINGUM
GUERNSEY
BELMONT
NOBLE
MONROE
23
PICKAWAY
MORGAN
HOCKING
33
WASHINGTON
River
ROSS
ATHENS
23
50
VINTON
50
33
35
MEIGS
PIKE
JACKSON
Above 1000 Feet MSL
County Boundary
U.S. Highway
Ohio River
Ohio
GALLIA
0
5
10
Scale in Miles

Measurements

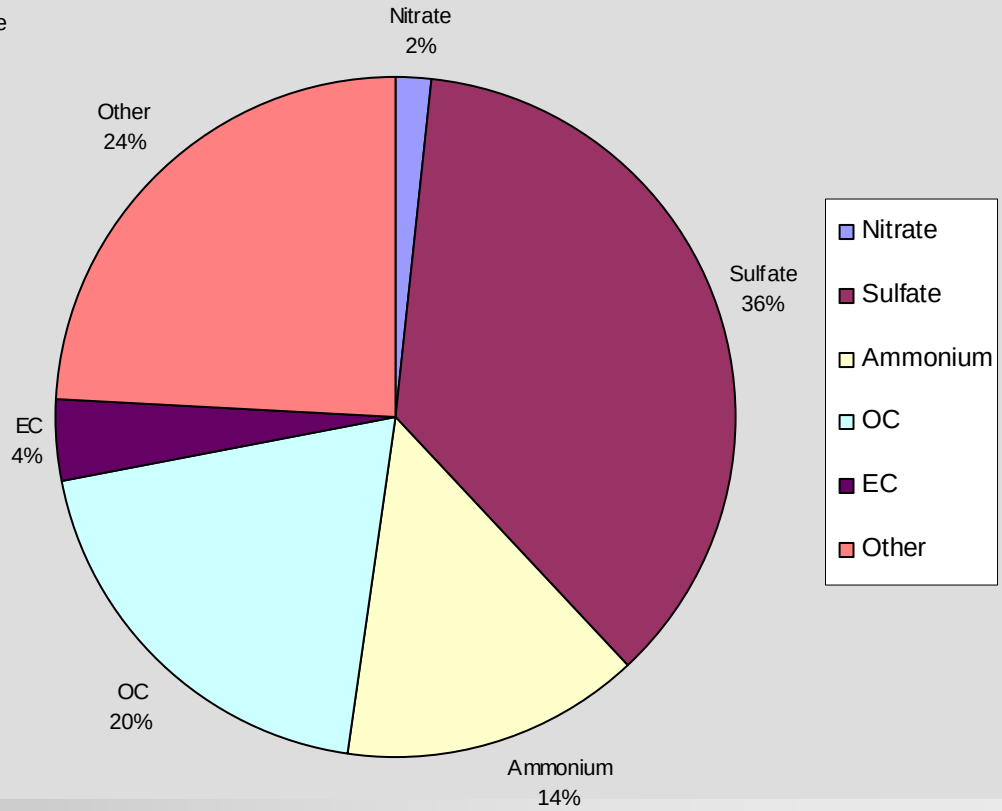
Species of Concern	Observed	Resolution
Mercury	Hg^0, RGM, Hg_p	120 min
Wet Deposition	Total Mercury	1 week
Gases	SO_2, NO_x, CO, O_3	1 min
Fine Particulate	TEOM ($PM_{2.5}$)	10 min
	Federal Reference Method	3 days
Met (approx 100m)	WS, WD	1 min
Met (10 m)	WS, WD, Temp, BP, RH, Precip.	1 min
Ammonia	NH_3, HNO_3, SO_2, $SO4^{2-}$, NO^{3-}, NH^{4+} , $PM_{2.5}$	6 days


Monthly Distribution of PM2.5 Concentration, 2004
PM2.5 Concentration (ug/m3)
50
40
30
20
10
0
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
NAAQS
(Annual Average)
MAX
MIN
MEAN+SD
MEAN-SD
MEAN

Warm season $PM_{2.5}$ composition (April ~ Sept)



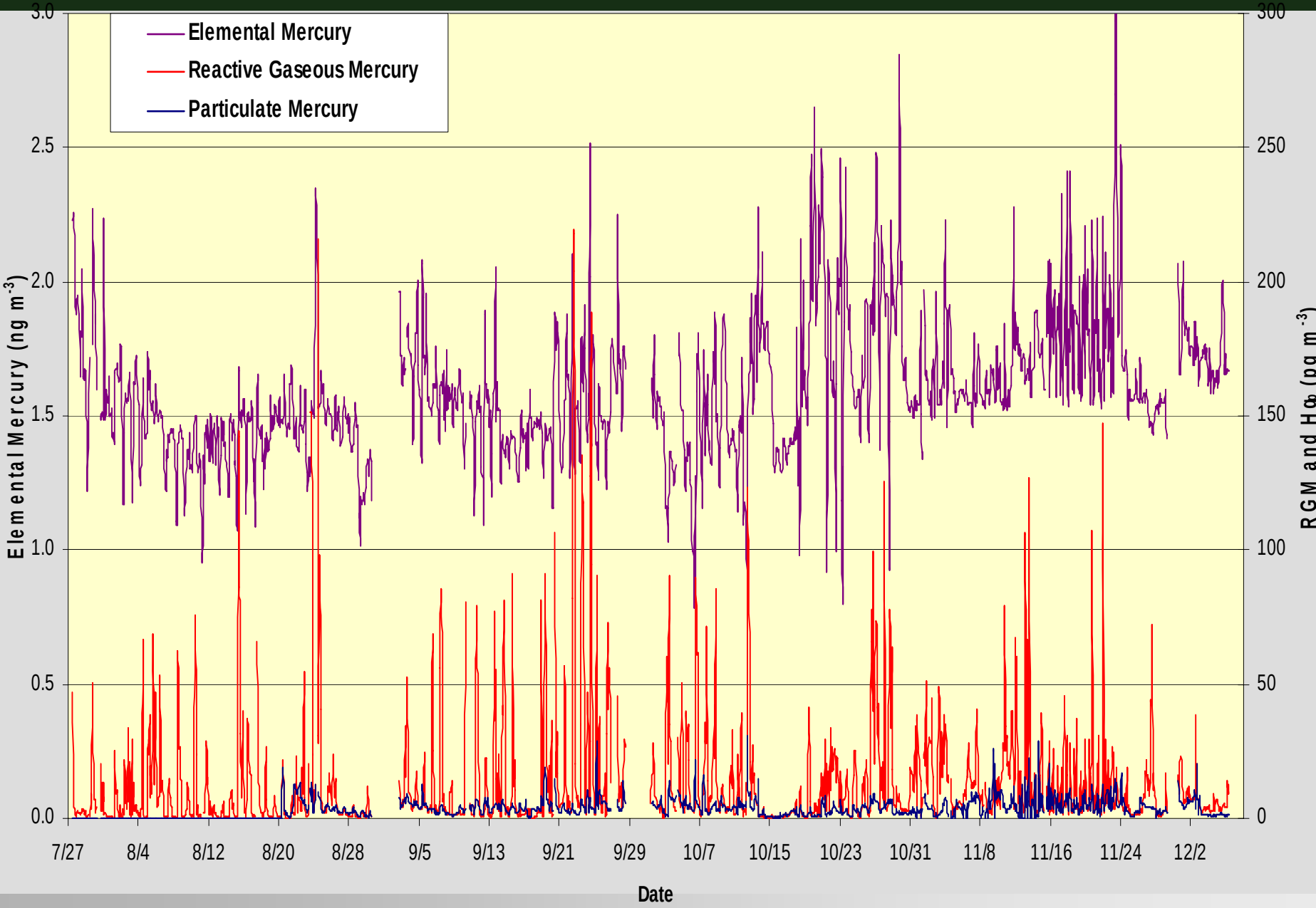
Cool season $PM_{2.5}$ composition (Oct ~ March)



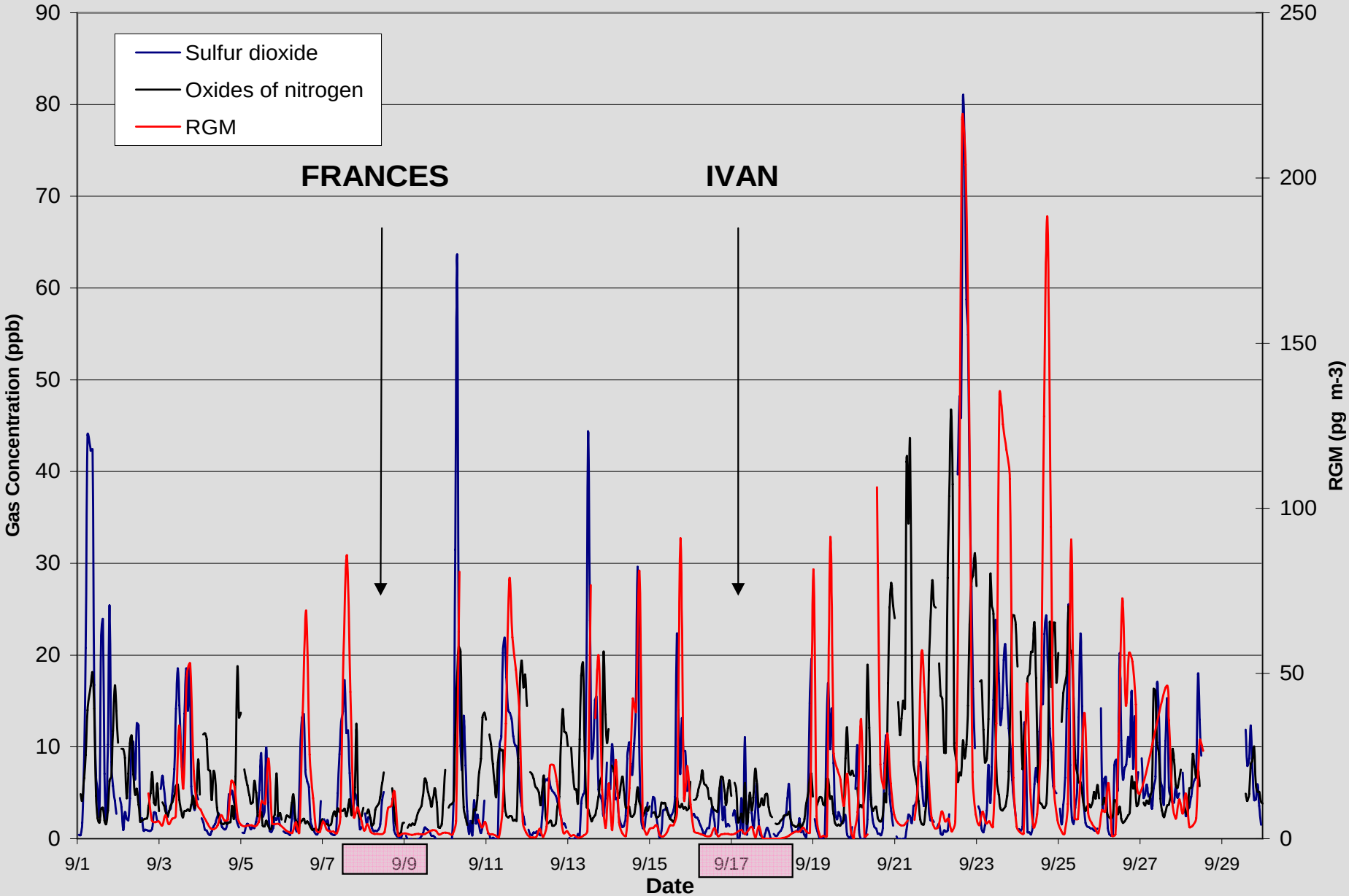
Mercury

- **Speciation**
  - **Elemental mercury (Hg^0):** long range transport, stable in the atmosphere, ng/m^3
  - **Reactive Gaseous Mercury (RGM/Hg^{2+}):** Local deposition, soluble in water, pg/m^3
  - **Particulate mercury (Hg_p):** Local deposition, associate with fine PM, pg/m^3

Time Series of all Mercury Species (Athens, Ohio)



September 2004 Gas & RGM Trends



Potential Source Contribution Function (PSCF)

- PSCF has been used for air pollution source apportionment and source-receptor relationship studies.
- $PSCF_{ij}$ is the conditional probability that an air parcel that passed through the *ij*th cell has a concentration higher than the threshold criterion upon arrival at the monitoring site

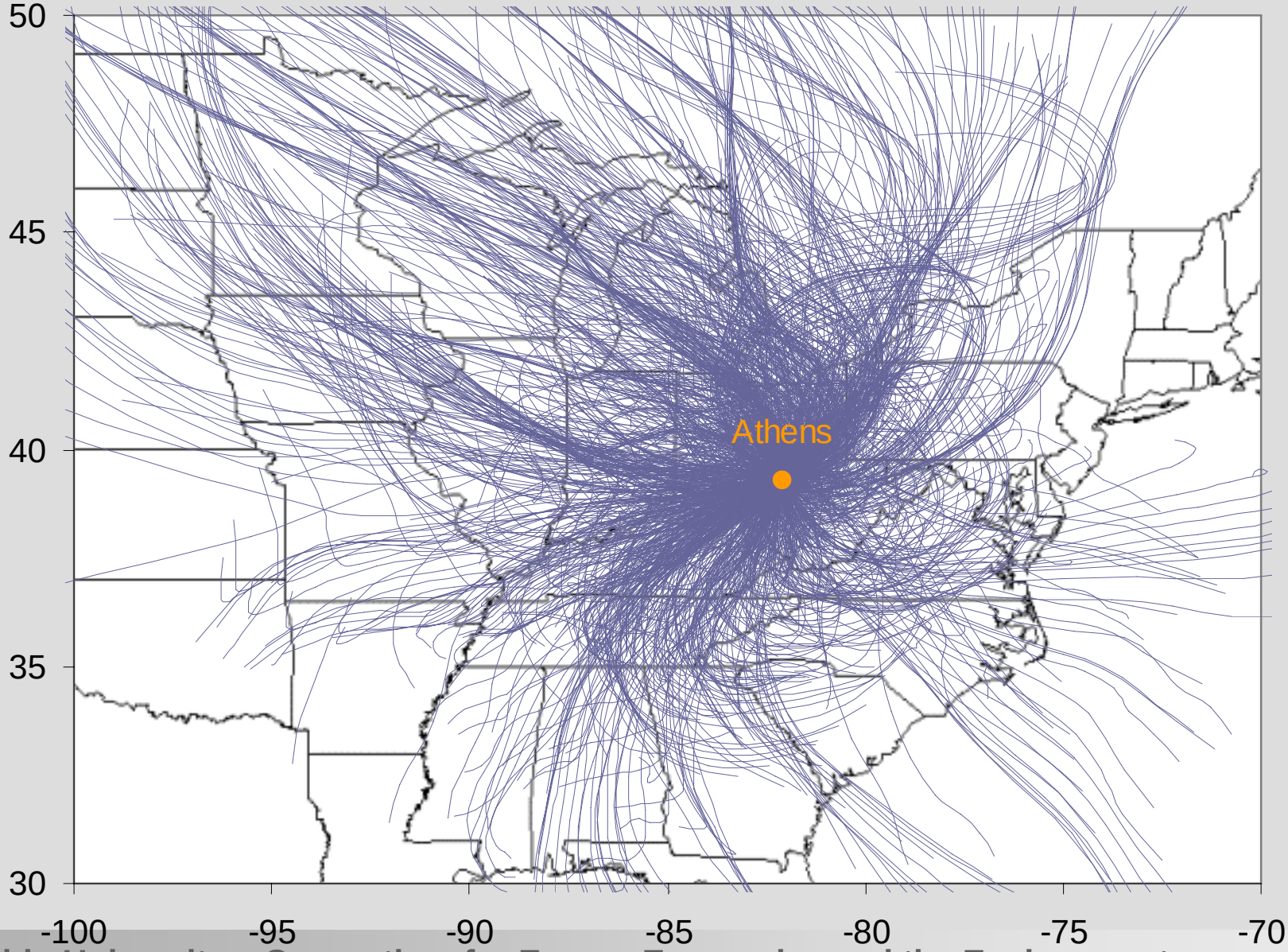
$$PSCF_{ij} = \frac{m_{ij}}{n_{ij}}$$

n_{ij} : total number of end points that fall in the *ij*th cell

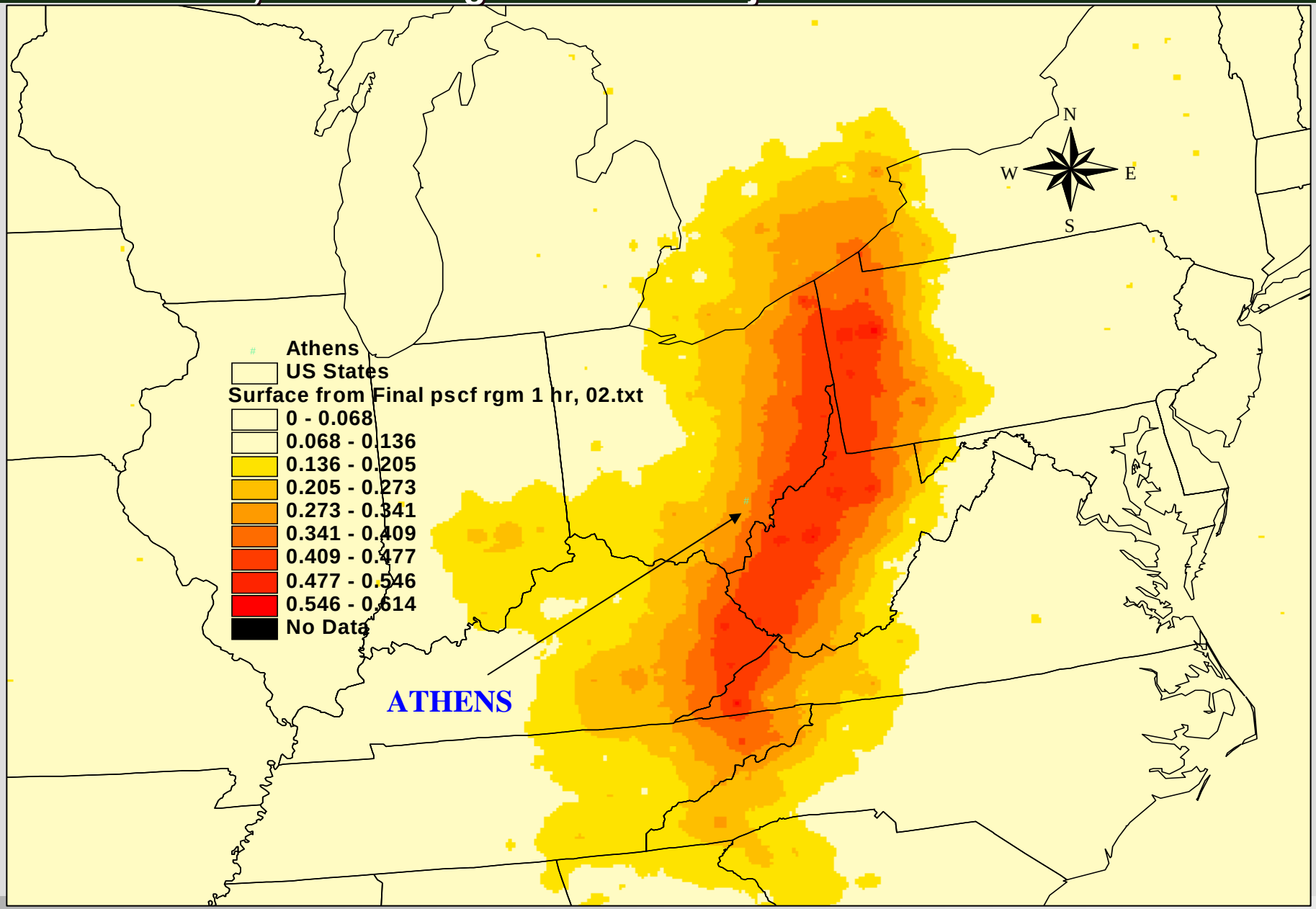
m_{ij} : number of end points that exceeded the threshold criterion

(in this study, average concentration of RGM was used for the threshold criterion)

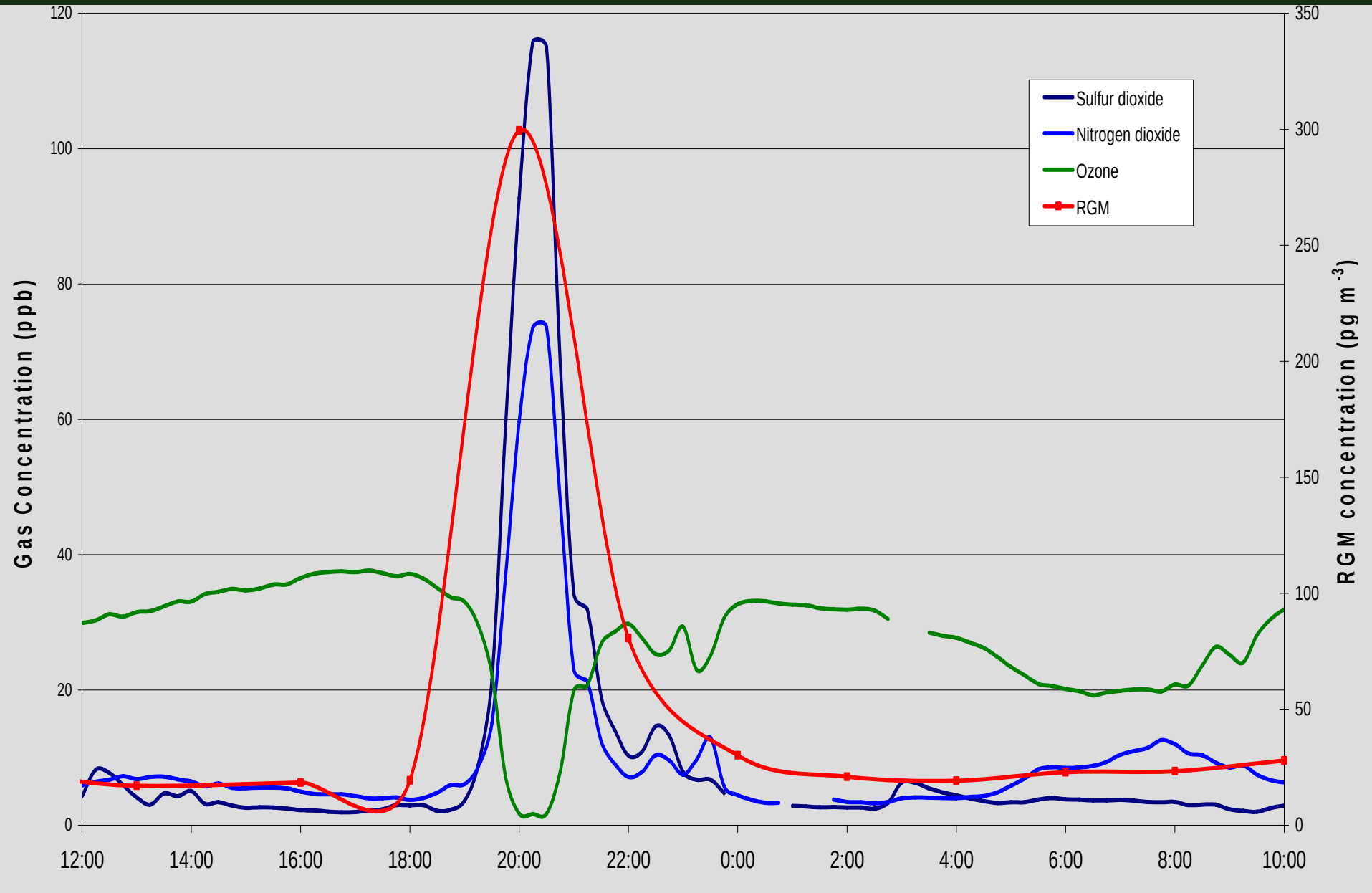
5-day Backward Trajectory

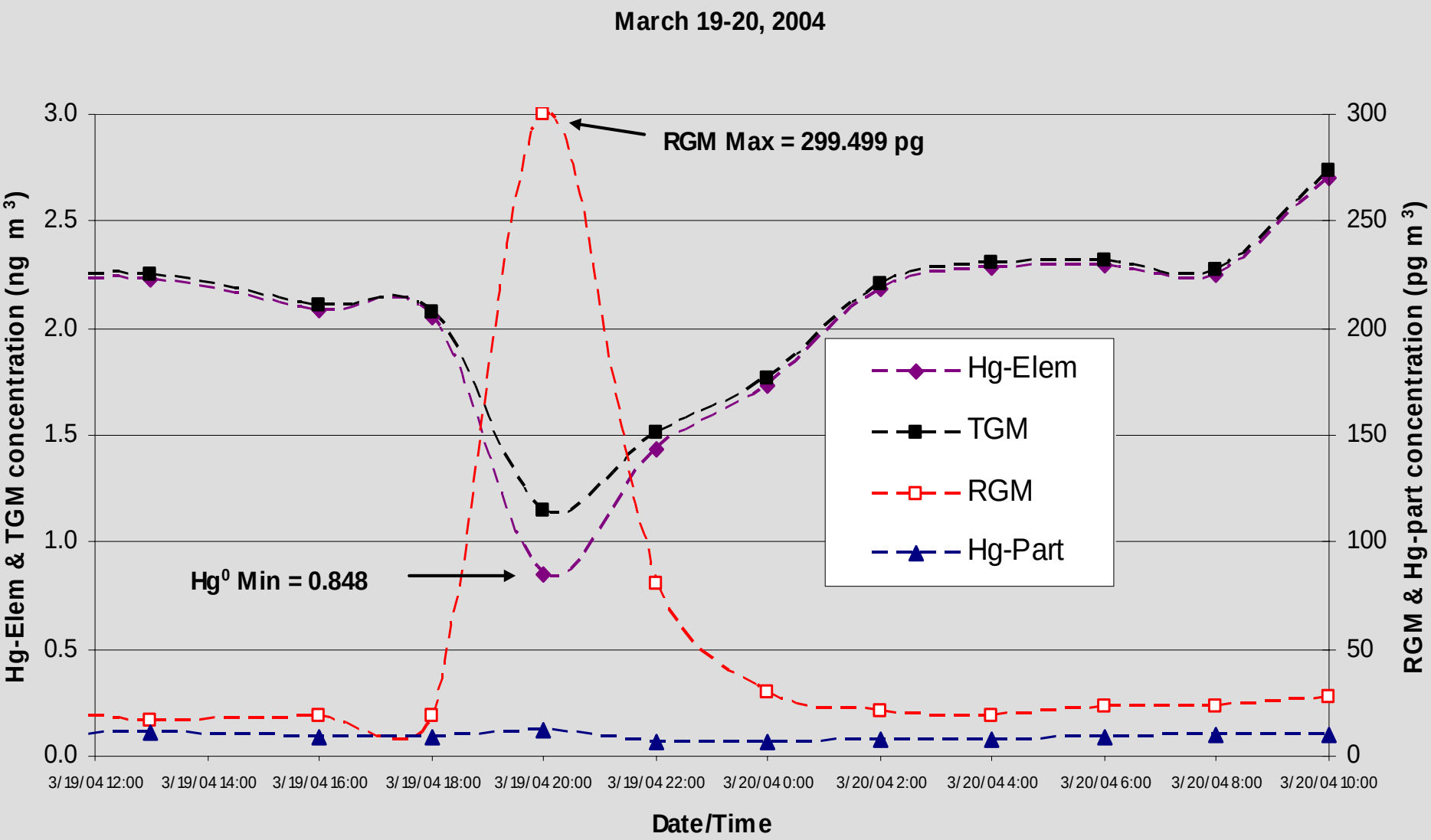


Possible Source region for RGM. Measurements from July 27 2004 ~ March 28, 2005. Using 24 hr back-trajectories

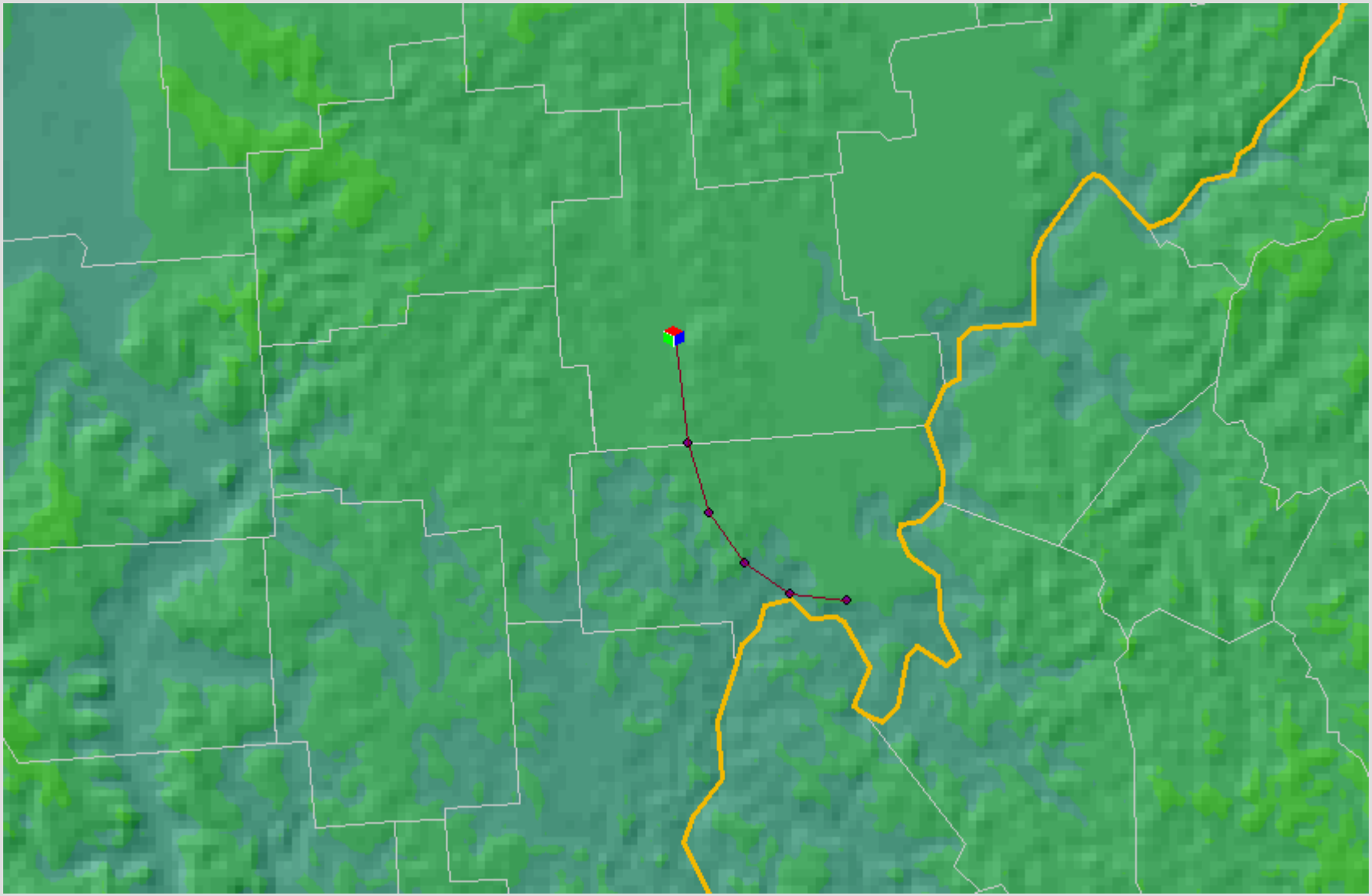


Plume Impact of March 19-20, 2004 (Athens, Ohio)

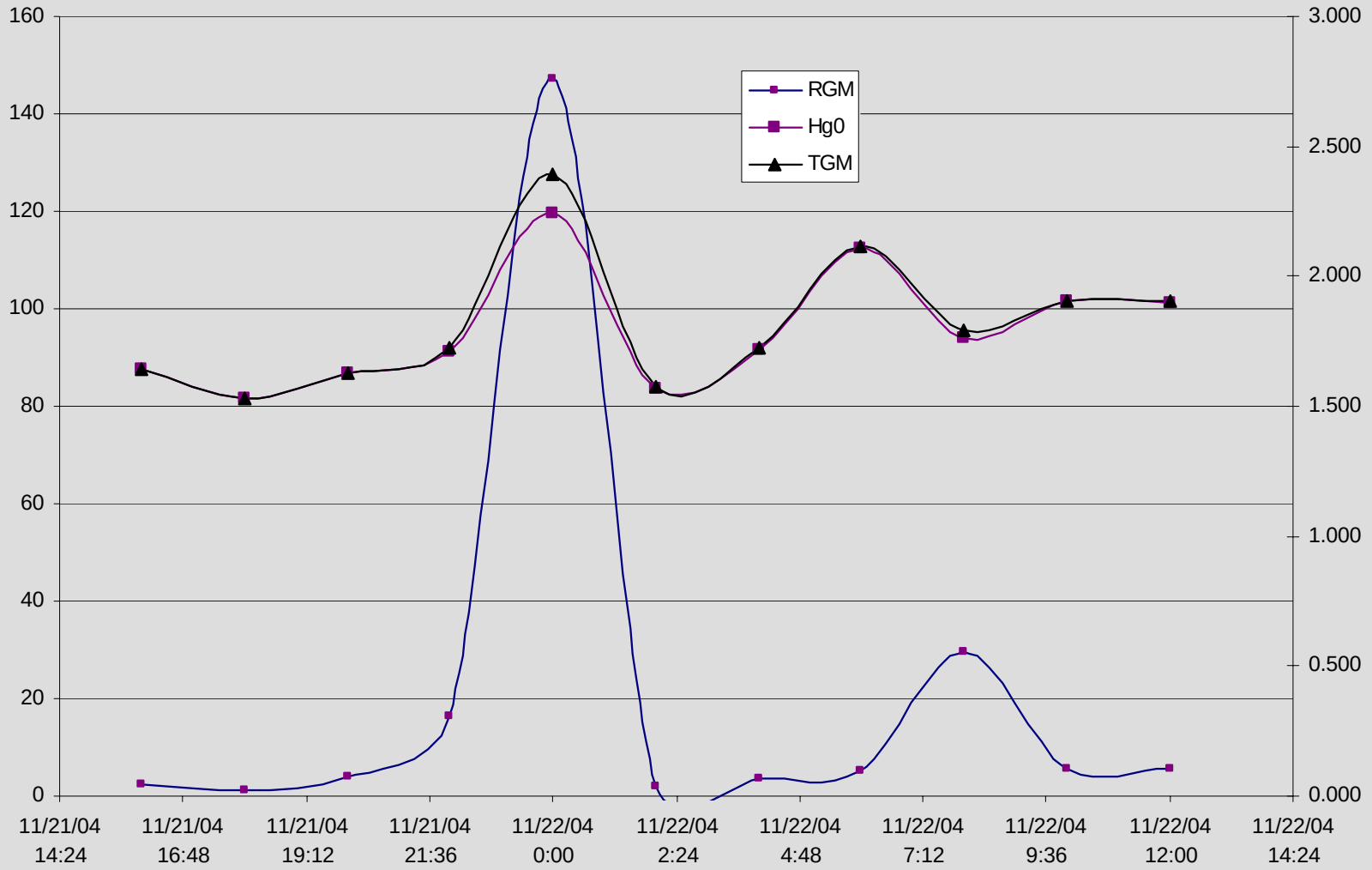


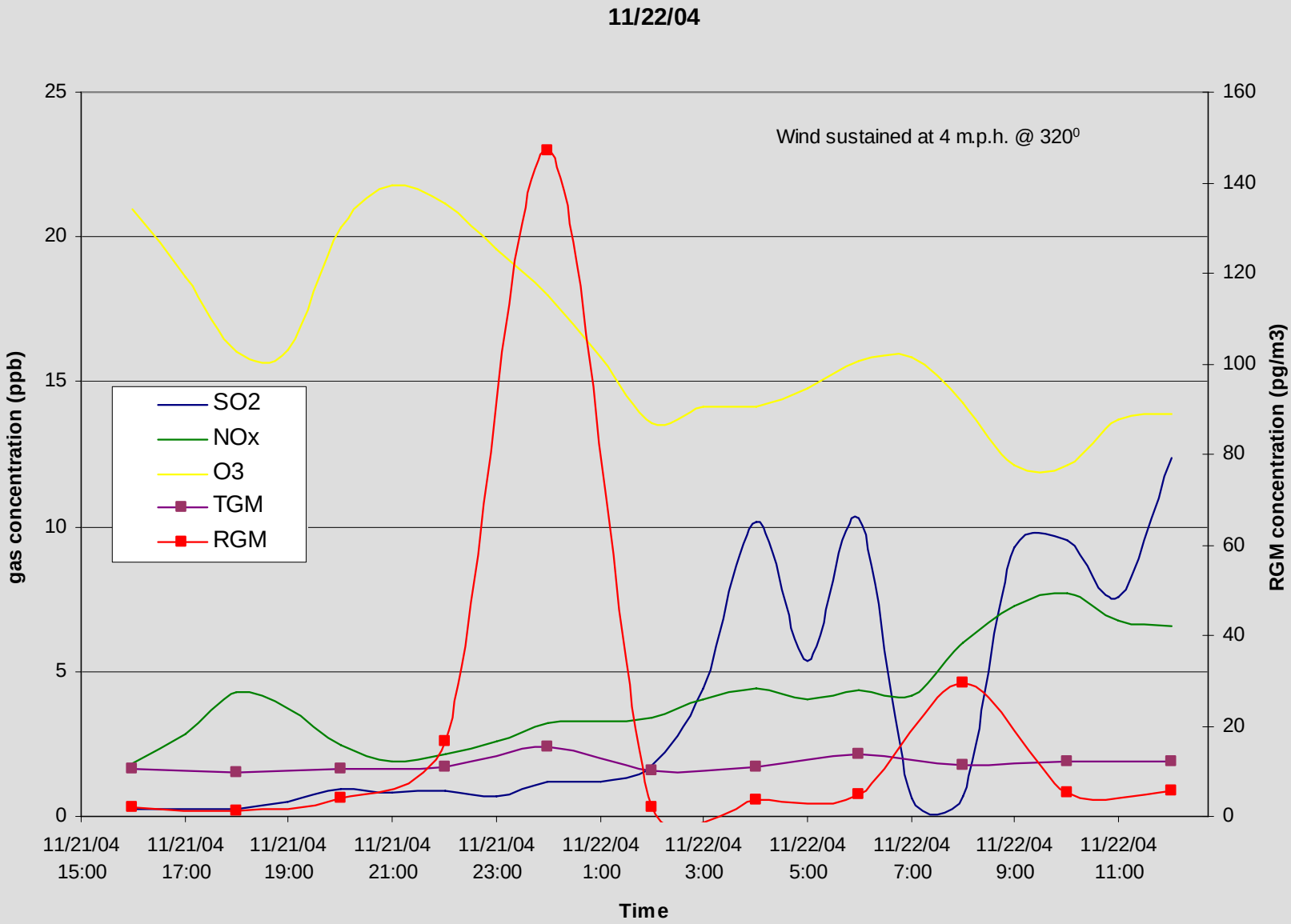

March 19-20, 2004
RGM Max = 299.499 pg
Hg⁰ Min = 0.848
Hg-Elem
TGM
RGM
Hg-Part
Hg-Elem & TGM concentration (ng m⁻³)
RGM & Hg-part concentration (pg m⁻³)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
300
250
200
150
100
50
0
3/19/04 12:00
3/19/04 14:00
3/19/04 16:00
3/19/04 18:00
3/19/04 20:00
3/19/04 22:00
3/20/04 0:00
3/20/04 2:00
3/20/04 4:00
3/20/04 6:00
3/20/04 8:00
3/20/04 10:00
Date/Time

(5-hour back trajectory)



Nov of 2004


160
140
120
100
80
60
40
20
0
3.000
2.500
2.000
1.500
1.000
0.500
0.000
RGM
Hg0
TGM
11/21/04 14:24
11/21/04 16:48
11/21/04 19:12
11/21/04 21:36
11/22/04 0:00
11/22/04 2:24
11/22/04 4:48
11/22/04 7:12
11/22/04 9:36
11/22/04 12:00
11/22/04 14:24


11/22/04
Wind sustained at 4 m.p.h. @ 320⁰
gas concentration (ppb)
RGM concentration (pg/m3)
SO2
NOx
O3
TGM
RGM
25
20
15
10
5
0
160
140
120
100
80
60
40
20
0
11/21/04 15:00
11/21/04 17:00
11/21/04 19:00
11/21/04 21:00
11/21/04 23:00
11/22/04 1:00
11/22/04 3:00
11/22/04 5:00
11/22/04 7:00
11/22/04 9:00
11/22/04 11:00
Time

Wet Deposition Sampler

- Mercury Deposition Network (MDN)
- Associated with both rain and snow events
- Sample collection every week
- Analyzed for total mercury content

Total Mercury Wet Deposition, 2003